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Original Article

The Impact of SIX SIGMA DMAIC Methodology in the Effective Pharmacy Inventory Management System in a Major Trauma Care Center – A Prospective Observational Study

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ABSTRACT

Objectives: Define the defects in the inventory management process to identify the opportunities with high potential for improvement and also to measure the identified errors and quantify them to obtain statistical and graphical data. **Materials and Methods:** The study was conducted in the department of pharmacy in a major trauma care center in Tamil Nadu, India for Six months by using SIX SIGMA DMAIC TOOL. The study was conducted in the four major pharmacy management system units of the trauma care center which included the store, pharmacy, infirmary unit, and return medication counter. **Results:** The impact of inventory management was analyzed, where we observed changes in sigma value which eventually visualized the improvisation in inventory management system. **Conclusion:** We could conclude that, use of six sigma DMAIC methodology reduced the number of errors from procurement facets, distribution facets, infirmary unit facets, and return medicine unit in the major trauma care center.

Keywords: Inventory management, Six Sigma, Pharmacy, Errors, Improve, DMAIC, Procurement, distribution, Infirmary, supply chain management, Discrepancies.

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INTRODUCTION

Inventory control is the method of keeping the proper variety of components and products to avoid shortages, surplus stores, and different inventory-connected issues. Future demand, production management, chain management, financial flexibility, purchasing expertise, loss prevention, turnover, and client pleasure are a few components of inventory control.[1]

Inventory management includes a series of processes that influence the flow medicine of medicine from the manufacturer to the pharmacy store and is provided to various pharmacies within the hospital from wherever the drugs square measure distributed to the patients in keeping with their desires. This method is put together and called Supply chain management. Economical inventory management ensures continuous production by maintaining inventory at a satisfactory level. It additionally minimizes capital investment and the price of inventory by avoiding stockpiles of products.

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Businesses will be able to flex and adapt rapidly regardless of market conditions, difficulties, or organizational changes if they have the right inventory management solution in place. As a result, they will meet demand and prevent overstocking.[2] The term "chain management" was first used in the age of production, which allowed organizations to consult a network of partners on matters such as supply, inventory control, transportation, information, sourcing, and competitive analysis with a high degree of flexibility and a focus on customer or market demand.[3]

The commonest and most generally used tools and techniques that are applied for coming up with the acquisition, storage, movement, and management of materials in an exceedingly hospital store are: Always Better Control (ABC) analysis, Vital Essential Desirable (VED) analysis, Economic Order Quantity (EOQ), Lead time and Buffer stock.

The six sigma approach has grown immensely in popularity and usage over the past 20 years, becoming widely used in a variety of organizations and industries.[7] Motorola created the Six Sigma methodology for mistake reduction in the 1980s with the goal of methodically reducing flaws in processes. Six Sigma is an effective method that increases corporate process effectiveness and drastically lowers product faults.[8] Its objective is to lessen variability in business operations from a statistical perspective. Having no more than 3.4 faults per million opportunities in any process, product, or service is what Six Sigma formally refers to when employed as a measurement.

In order to ensure that a given process is 99.99% error-free, the objective is to rebuild it to Six Sigma specifications. Six Sigma is one of the best quality improvement methodologies which currently finds its application in healthcare.[11] This management approach is widely used in the health sector to save expenses, waste, and time. Increasing efficiency could assist healthcare institutions in maintaining or improving outcomes in the complicated context of today's healthcare system, which is constrained by financial restrictions.[17] In this regard, scholars and professionals are becoming more interested in using Six Sigma to solve health process improvements.[13] The majority of this research is done through case studies that demonstrate Six Sigma implementations in various parts of a medical organisation.[16]

An organization can manage the quantity of cash held in the inventory balance with the aid of inventory control.[4] The Six Sigma (SS) technique has gained enormous popularity and extensive adoption over the past 20 years across a variety of organisations and industries.[14] Six Sigma is an effective method that increases corporate process effectiveness and drastically lowers product faults. Six Sigma is an effective method that increases corporate process effectiveness and drastically lowers product faults.[15]

Six Sigma is a comprehensive, business-driven approach to process optimisation, lower expenses, and higher profit. It aids in cost reduction and product quality improvement.[9] Six Sigma measures 3.4 Defects Per Million of Opportunities (DPMO) and it operates on the concept of DMAIC.

Six Sigma can be defined as:

- A statistical evaluation of how well a procedure or a product performs.
- A target for performance enhancement that is almost flawless.
- A management framework for achieving world-class performance and enduring corporate leadership.

This study makes use of **DMAIC** (Define-Measure-Analyze-Improve-Control) methodology which refers to a data-driven improvement cycle used for improving, optimizing, and stabilizing processes as shown in Figure 1, in the pharmacy inventory management system, thereby facilitating an effective inventory management system in a major trauma care centre.

MATERIALS AND METHODS

Study Design

A Prospective observational study on the impact of Six Sigma DMAIC methodology in the effective pharmacy inventory management system in a major trauma care centre.

Study Tool

Six sigma DMAIC methodology.

Study Procedure

The study was conducted at the department of Orthopedics and plastic surgery, Ganga Hospital, Coimbatore for a period of six months (April 2021 to October 2021). We collected 12,000 data in total from in-patient pharmacy, out-patient pharmacy, infirmary units and return medicine units of Ganga hospital using individual checklists made for each facet. Data were collected according to the objectives of different phases of the DMAIC methodology. All the drugs were from IP pharmacies, OP pharmacies, infirmary units, and return medicine units in the hospital were included in the study. Broken and contaminated ampoules, vials, and IV fluids were excluded from the study. The collected data were to be quantified and compared with the previously collected data to ensure significant improvement with the implementation of the Six Sigma DMAIC methodology.

Phase I: Define (*n*=100)

In the Define phase, a pareto chart was prepared with 100 cases to evaluate the major types of errors in the four different facets. The define phase revealed discrepancies in procurement facets, distribution facets, infirmary unit facets, and return medicine unit facets. The majorly affected discrepancy in inventory control management was found to be the discrepancies in infirmary unit facets and return medicine unit facets.

Phase II: Measure Phase (*n*=6000)

During the data collection process, a total of 6000 samples were taken and reviewed for inventory management errors. Out of the data collected, the number of defects in the processes was found and their corresponding sigma values were calculated.

The data collected in the measure phase were analyzed to determine defects in each category by Defects Per Unit (DPU) and Defects Per Million Opportunities (DPMO).

$$DPU=\frac{\text{Total defects found in a sample}}{\text{Total Sample}}$$

$$DPMO=\frac{\text{Total number of defects found in a sample}*1,000,000}{\text{Total number of defect opportunities in a sample}}$$

Discrepancies found in procurement facets include errors in attestation, improper intend to supply, and errors in purchased

Figure 1: Six Sigma Cycle.

goods. Discrepancies found in distribution facets include errors in cut medicines, errors in drug segregations, errors in drug movement, errors in FIFO, and errors in box interchange. Discrepancies found in infirmary unit facets include errors in drug shortage, errors in excess drugs, errors in short-expiry drugs, errors in documentation, and errors in expiry drugs. Discrepancies found in return medicine unit facets include errors in batch number, errors in drugs returned, errors in documentation, and errors in short-expiry drugs.

Phase III: Analyze

Root cause analysis is an important process in the DMAIC methodology which enables to analyze the major reason for the discrepancies that happen to occur. The root cause analysis can be represented by the fish bone diagram, also known as the Ishikawa diagram. The fish bone diagram or cause and effect diagram identify possible causes for an effect or a problem.

The root causes of the problems identified in the procurement phase are infrequent monitoring of drug movement, increased supply lead time, stock out of drugs, and wrong system transfer. The root cause of the problems identified in the distribution phase are improper maintenance of short expiry and cut medicines, lack of knowledge, improper intend placing, and no up-to-date billing.

Major problems identified in infirmary units are protocol in adherence, improper documentation, improper maintenance of short-expiry drugs, and prescription refill without checking. Major problems identified in return medicine units are over intending drugs, short-expiry drugs, lack of communication with patients, and wrong patient billing.

Phase IV: Improve (*n*=6000)

To measure the improvement in improve phase (Phase IV), 6000 data were collected, quantified, and compared to the data collected in the measure phase. In improve phase, an action plan was implemented and followed for continuous improvement in inventory management. For every root cause found, corrective action was planned. These errors were rectified and quality standards for inventory management were established. The root causes and their corrective action plans are represented in the Lovebug diagram.

For example, in the procurement phase increased supply lead time was rectified by the on-time placing of purchase orders. Similarly, in the distribution phase, improper intend placing was rectified by frequent monitoring of FSN analysis and drug stock levels.

Finally, data collected in the measure phase were compared with the data collected in improve phase, and sigma values were calculated. A significant improvement in sigma level was observed in procurement, distribution, infirmary units, and return medicine unit facets.

Phase V: Control (*n*=100)

In the control phase, 100 cases were gathered, and the regulated number of errors was tracked using a control chart.

RESULTS

A total of 12,200 data were collected for the study purpose. In this study a quality improvement tool named Six Sigma DMAIC methodology was applied in five phases namely; Define, Measure, Analyze, Improve, and Control phase in four different facets of the pharmacy inventory management system namely; procurement facets, distribution facets, infirmary unit facets and return medicine unit facets.

Define Phase

In the Define phase, a pareto chart was prepared with 100 cases to evaluate the major types of errors in the four different facets. The define phase revealed that out of 100 data 67 discrepancies were found. Among these 16(23.88%) discrepancies in procurement facets, 13(19.4%) discrepancies in distribution facets, 21(31.34%) discrepancies in infirmary unit facets, and 17(25.37%) discrepancies in return medicine unit facets were found. The majorly affected discrepancy in inventory control management was found to be the discrepancies in infirmary unit and return medicine unit. These data are graphically demonstrated in Figure 2.

Measure Phase

Discrepancies in Procurement Facets

In the measure phase, a total of 354 procurement facet errors were detected out of 1200 data among which 197(16.41%) errors in attestation, 119(9.91%) improper intend supply, 38(3.16%) errors in purchased goods were identified.

Followed by, in the improve phase, 1200 data were collected to observe a significant reduction in procurement facet errors. The number of procurement facet errors was found to be 118 with a rise in sigma value from 3.06 to 3.56, as shown in Table 1.

Discrepancies In Distribution Facets

In the measure phase, a total of 1465 distribution facet errors were detected out of 2500 data among which 569(22.76%) cut medicines, 327(13.08%) drug segregations, 193(7.72%) errors in drug movement, 165(6.6%) errors in FIFO, 138(5.52%) box interchanges were identified.

Followed by, in the improve phase, 2500 data were collected to observe a significant reduction in distribution facet errors. The number of distribution facet errors was found to be 413 with a rise in sigma value from 2.19 to 2.98, as shown in Table 2.

Discrepancies in Infirmary Unit Facets

In the measure phase, a total of 686 infirmary unit facet errors were detected out of 2000 data among which 372(18.6%) drug shortage, 164(8.2%) excess drugs, 94(4.7%) short expiry drugs, 50(2.5%) errors in documentation and 6(0.3%) expiry drugs were identified.

Followed by, in the improve phase,2000 data were collected to observe a significant reduction in infirmary unit facet errors. The number of infirmary unit facet errors was found to be 385 with a rise in sigma value from 2.70 to 3.02, as shown in Table 3.

Discrepancies in Return Medicine Unit Facets

In the measure phase, a total of 206 return medicine unit facet errors were detected out of 300 data among which 94(31.33%) errors in batch number, 46(15.33%) drugs returned, 37(12.33%) errors in documentation, and 29(9.66%) short expiry drugs were identified.

Followed by, in the improve phase, 300 data were collected to observe a significant reduction in return medicine unit facet errors. The number of return medicine unit facet errors was found to be 158 with a rise in sigma value from 3.32 to 3.44, as shown in Table 4.

Analyze Phase

Root cause analysis is an important process in the DMAIC which enables it to provide the major reason for the discrepancies that happen to occur.

The root cause analysis can be represented by the fishbone diagram also known to be Ishikawa diagram.

The fishbone diagram or cause and effect diagram identify possible causes for an effect or problem.

The various defects in inventory management facets namely Procurement, Distribution, Infirmary units and Return medicine counter are depicted in Figures 3, 4, 5 and 6 respectively.

Improve Phase

In improve phase, an action plan was implemented and followed for continuous improvement in inventory management.

For every root cause found, corrective action was planned.

These errors were rectified and quality standards for inventory management were established.

The root causes and their corrective action plan are given below (Figure 7) in the Lovebug diagram. The action plan for inventory associated facets is depicted in Figure 8.

Lourdes Model of Inventory

The drugs from different units were categorized according to ABC, VED and FSN analysis. In our study we combined the three analytical processes and classified the drugs into three

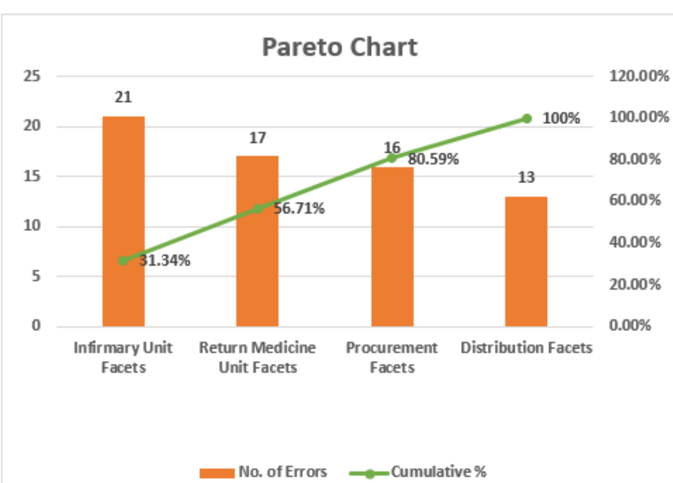

Figure 2: Inventory Associated Facets (*n*=100).

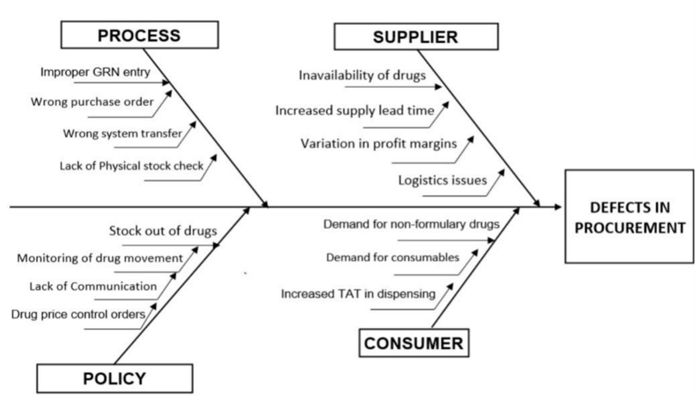

Figure 3: Ishikawa Diagram- Procurement.

Table 1: Procurement Facets.

Procurement Facets	Phase II (Measure)	Phase IV (Improve)	Phase II%	Phase IV%
Attestation	197	69	16.41	5.75
Intend Supply	119	32	9.91	2.66
Purchased Goods	38	17	3.16	1.41
Purchase Order	0	0	0	0
RQL	0	0	0	0
No Errors	846	1082	70.5	90.16
Total	1200	1200	100	100

Table 2: Distribution Facets.

Distribution Facets	Phase II	Phase IV	Phase II%	Phase IV%
Cut Medicines	569	138	22.76	5.52
Drug Segregation	327	96	13.08	3.84
Drug Movement	193	73	7.72	2.92
FIFO	165	54	6.6	2.16
Box Interchange	138	34	5.52	1.36
Short Expiry	73	18	2.92	0.72
No Errors	1035	2087	41.4	83.48
Total	2500	2500	100	100

Table 3: Infirmary Unit Facet.

Infirmary Unit Facets	Phase II	Phase IV	Phase II%	Phase IV%
Shortage	372	196	18.6	9.8
Excess	164	98	8.2	4.9
Short Expiry	94	52	4.7	2.6
Documentation	50	39	2.5	1.95
Expiry	6	0	0.3	0
No Errors	1314	1615	65.7	80.75
Total	2000	2000	100	100

major class namely; drugs which need to be kept in large stock, moderate stock and least stock. This classification was mainly based on the lead time, buffer stock, RQL, need of the drug, drug movement and the cost of the drugs. Lourdes Model of Inventory emphasized the inventory pattern and helped in the reduction of inventory burden.

The comparison of phase II (measure) and phase IV (improve) after the implementation of the Six Sigma DMAIC methodology is depicted below which shows significant improvement in sigma levels. The measure phase showed 354, 1465, 686, and 206 respectively. It improved to 118, 413, 385, and 158 respectively in the improve phase which is depicted in the Table 5.

Control Phase

In the Control phase, a control chart was prepared with 100 cases to evaluate the major types of errors in the 4 different facets. The define phase revealed that out of 100 data 34 discrepancies were found. Among these 8(23.5%) discrepancies in procurement facets, 6(17.6%) discrepancies in distribution facets, 11(32.35%) discrepancies in infirmary unit facets, and 9(26.47%) discrepancies in return medicine unit facets were found as shown in Table 6.

DISCUSSION

The prospective observational study was carried out for a period of six months in a major trauma care centre. This study is similar to a study conducted by the literature of Walters LM *et al.* which explains how data analytics within the framework of Six Sigma Quality, known as DMAIC (Define, Measure, Analyze, Improve, and Control), was used to diagnose and improve the inventory management process.

In our study also the same quality improvement tool named Six Sigma DMAIC methodology was applied in five phases such as Define, Measure, Analyze, Improve, and control phase in four different facets of the pharmacy inventory management system

Table 4: Return Medicine Unit Facets.

Return Medicine Unit Facets	Phase II	Phase IV	Phase II%	Phase IV%
Batch Number	94	68	31.33	19.66
Quantity Returned	46	37	15.33	12.33
Documentation	37	31	12.33	10.33
Short Expiry	29	22	9.66	7.33
No Errors	94	142	31.33	47.33
Total	300	300	100	100

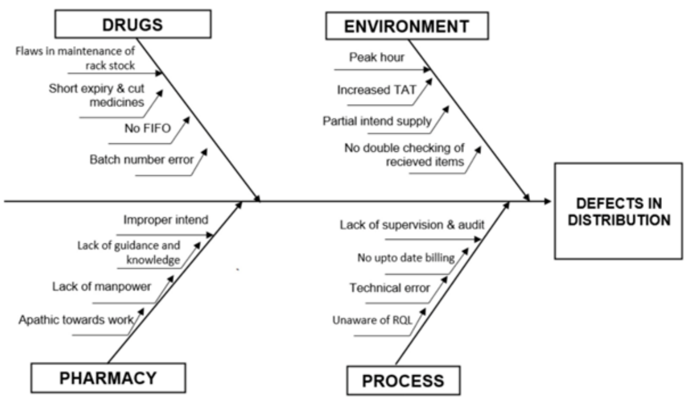

Figure 4: Ishikawa Diagram-Distribution.

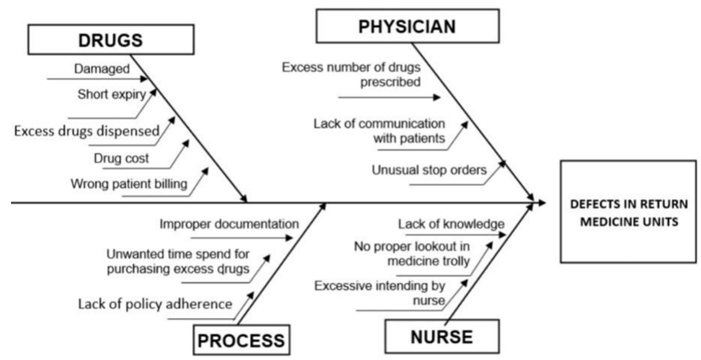

Figure 6: Ishikawa Diagram- Return Medicines Unit.

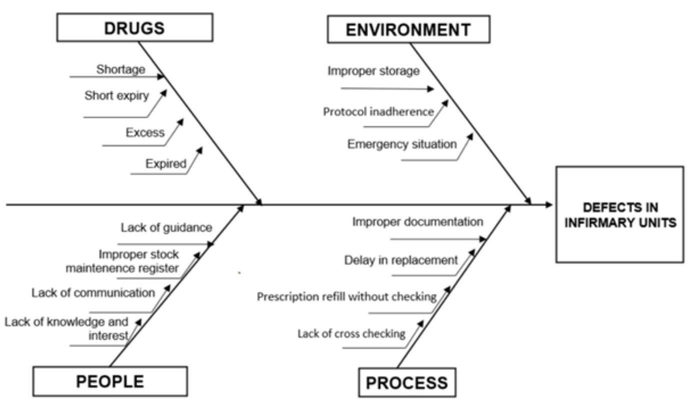

Figure 5: Ishikawa Diagram- Infirmary Units.

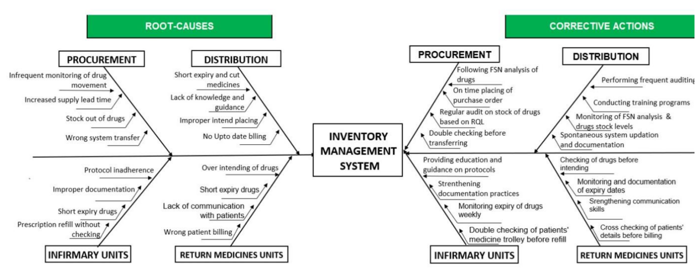

Figure 7: Improve Phase-Love Bug Diagram Showing Root Cause and Action Plan for Inventory-Associated Facets.

namely; procurement facets, distribution facets, infirmary unit facets and return medicine unit facets.

A total of 12,200 data were collected for the study purpose. In the define phase, a control chart was prepared with 100 cases to evaluate the major types of errors in the four different facets in Table 1. The define phase revealed that out of 100 data 67 discrepancies were found. Among these 16(23.88%) discrepancies in procurement facets, 13(19.4%) discrepancies in distribution facets, 21(31.34%) discrepancies in infirmary unit facets, and 17(25.37%) discrepancies in return medicine unit facets were found. The majorly affected discrepancy in inventory control management was found to be the discrepancies in infirmary unit facets with 31.34%. Followed by the define phase, the team moved

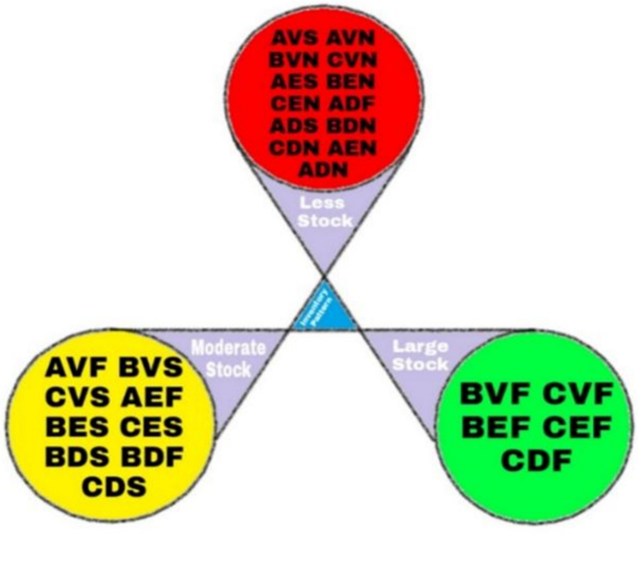

Figure 8: Action Plan - Lourdes Model of Inventory.

Red: Drugs to be stored in low stock.
Yellow: Drugs to be stored in moderate stock.
Green: Drugs to be stored in large stock.

on to the measure phase in which a data collection form was generated to collect different data. 6000 data were collected in this phase among which 2711 errors were detected. The Defects Per Unit (DPU), Defects Per Million Opportunities (DPMO), and corresponding sigma values of each of the errors were calculated.

On consideration of the measure phase, a previous study conducted by Joy Muhia *et al.* regarding the factors affecting the procurement of pharmaceutical drugs (inadequate funds, bureaucracy, poor quantification, transportation of drugs),[5] was similar to our study in which a total of 354 procurement facet errors were detected out of 1200 data among which 197(16.41%) errors in attestation, 119(9.91%) improper intend supply, 38(3.16%) errors in purchased goods were identified. These errors were recognized to be due to lack of knowledge, inexperienced professionals, improper GRN entry, lack of communication variation in profit margins, and infrequent monitoring of drug stocks. The sub-classes of procurement facet errors were plotted on a Pareto chart for further analysis. From the Pareto chart, attestation errors were highlighted to be focused on.

In the improve phase, the action plan to reduce procurement facet errors was prepared. The corrective measures included stock-taking, pharmacist audits, regular auditing, ensuring effective communication, the purchase officer can clarify any doubts regarding drugs with the clinical pharmacist, following FSN analysis, conducting separate audits on the observed issues, on time placing of the purchase order and double-checking goods before transferring were planned to avoid errors.

Followed by, in the improve phase, 1200 data were collected to observe a significant reduction in procurement facet errors. The number of procurement facet errors was found to be 118 with a rise in sigma value from 3.06 to 3.56. In the control phase, 100 cases were gathered, and the regulated number of errors was tracked using a control chart.

By correlating the previous study conducted by Ebenezer Tetteh which explained about distribution and network supply chains of medicines; determined facts such as shortening of public supply chain and quality assurance of supply chain,[12] to our study which quantified in the measure phase, a total of 1465 distribution facet errors were detected out of 2500 data among which 569(22.76%) cut medicines, 327(13.08%) drug segregations, 193(7.72%) errors in drug movement,165(6.6%) errors in FIFO, 138(5.52%) box interchanges were identified.

Our study figured out the notable factors for distribution facet errors which included lack of knowledge and guidance, inexperienced professionals, lack of communication, apathy of faculties towards work, no updating of billing, and lack of manpower. In the improve phase, the action plan to reduce the distribution facet errors was prepared. The corrective measures included performing frequent auditing, conducting training programs, monitoring FSN analysis and drug stock levels and simultaneous system updating and documentation were recommended to avoid errors.

Followed by, in the improve phase, 2500 data were collected to observe a significant reduction in distribution facet errors. The number of distribution facet errors was found to be 413 with a rise in sigma value from 2.19 to 2.98. In the control phase, 100 cases were gathered, and the regulated number of errors was tracked using a control chart.

Based on a previous study conducted by Paivi Anneli Hartikainen *et al.* which aimed to explore the perceptions of pharmacists on hospital wards (n=193).[6] Similarly, our study was able to detect a total of 686 infirmary unit facet errors in the measure phase. Out of 2000 data among which 372(18.6%) drug shortage, 164(8.2%) excess drugs, 94(4.7%) short expiry drugs, 50(2.5%) errors in documentation and 6(0.3%) expiry drugs were identified.

For route cause analysis, a fishbone diagram was used and the factors for infirmary unit facet errors were detected as, lack of knowledge and guidance, improper checking of drug stock in medicine trolley, excess no. of drugs prescribed, lack of communication, apathy of faculties towards work, and excessive intending by nurses. In the improve phase, the action plan to reduce the infirmary unit facet errors was prepared. The corrective measures included providing guidance and training based on protocol, strengthening the documentation process, monitoring drugs regularly, and double-checking patients' medicine trolleys before prescribing suggested to avoid errors.

Table 5: Error Comparison.

Inventory Associated Facets	Phase II (Measure)	Phase IV (Improve)	Phase II%	Phase IV%	Sigma Levels	
					Phase II	Phase IV
Procurement Facets	354	118	5.9	1.96	3.06	3.56
Distribution Facets	1465	413	24.41	6.88	2.19	2.98
Infirmary Unit Facets	686	385	11.43	6.41	2.70	3.02
Return Medicine Unit Facets	206	158	3.43	2.63	3.32	3.44
No Errors	3289	4926	54.81	82.1	-	-
Total	6000	6000	100	100	-	-

Table 6: Control Phase-Inventory Associated Facets (*n*=100).

Inventory Associated Facets	No. of Errors	Percentage
Procurement Facets	8	23.5
Distribution Facets	6	17.6
Infirmary Unit Facets	11	32.35
Return Medicine Unit Facets	9	26.47
Total	34	100

Followed by, in the improve phase, 2000 data were collected to observe a significant reduction in infirmary unit facet errors. The number of infirmary unit facet errors was found to be 385 with a rise in sigma value from 2.70 to 3.02. In the control phase, 100 cases were gathered, and the regulated number of errors was tracked using a control chart.

In the measure phase, a total of 206 return medicine unit facet errors were detected out of 300 data among which 94(31.33%) errors in batch number, 46(15.33%) drugs returned, 37(12.33%) errors in documentation, and 29(9.66%) short expiry drugs were identified.

The route cause analysis was performed based on a previous study conducted by Abhishek Jayswal *et al.* which explained the root cause analysis methodology[10] consistent with which the fishbone diagram was used in our study and the factors for return medicine unit facet errors were detected as over intending of drugs, lack of policy adherence, unusual stock orders, wrong patient dispensing, excess no. of drugs prescribed, improper documentation, and unwanted time spent for purchasing of excess drugs. In the improve phase, the action plan to reduce the return medicine unit facet errors was prepared. The corrective measures included checking drugs before intending, strengthening the documentation process, monitoring and checking the expiry date of drugs regularly, strengthening communication skills, and double-checking patients' details before billing were planned to avoid errors.

Followed by, in the improve phase, 300 data were collected to observe a significant reduction in return medicine unit facet errors. The number of return medicine unit facet errors was found to be 158 with a rise in sigma value from 3.32 to 3.44. In the control phase, 100 cases were gathered, and the regulated number of errors was tracked using a control chart.

CONCLUSION

The practice of Six Sigma DMAIC methodology showed a remarkable improvement in the inventory management system which includes proper GRN entry, proper purchase order, proper intending, arrangements of drugs in racks, maintenance of stock level, regular audit and thereby improving the clinical outcome of the patient and patient satisfaction.

The implementation of the Six Sigma DMAIC methodology showed a marked reduction of errors in procurement facets, distribution facets, infirmary unit facets, and return medicine unit. Correspondingly the Sigma rating has improved from 3.06, 2.19, 2.7, and 3.32 to 3.56, 2.98, 3.02, and 3.44 respectively.

By conducting daily audits and ensuring pharmacist compliance we could foresee a noticeable change in the inventory profit system and outperform in the betterment of stock management in pharmacies and thereby ensuring a proper supply of drugs to the patients.

It is evident that the application of the Six Sigma DMAIC methodology is extremely beneficial in rectifying Inventory based errors and thereby managing the total inventory system.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

Limitations

Several limitations were to be considered in interpreting the result of our project study. The most significant limitations are that;

- Only a few supportive articles were available for reference since the methodology of the present study is applied mostly in business, manufacturing, etc.

- Intangible outcomes may have influenced the study.

ABBREVIATIONS

SS: Six Sigma; **DMAIC:** Define Measure Analyze Improve Control; **ABC:** Always Better Control; **VED:** Vital Essential Desirable; **EOQ:** Economic Order Quantity; **DPMO:** Defects Per Million Opportunities; **IP:** In-Patient; **OP:** Out-Patient; **IV:** Intravenous; **DPU:** Defects Per Unit; **FIFO:** First in First Out; **FSN:** Fast Slow Non-Moving; **GRN:** Goods Receipt Notes.

SUMMARY

Inventory management is a crucial step, which should be monitored appropriately in order to achieve a balanced flow of processes in any set of organisations, especially in a healthcare organisation. Pharmacy inventory management is therefore a paramount method in developing standards to maximise patient safety. Improper management of pharmacy inventory has deleterious impacts on patient safety. Incorporation of a tool like SIX SIGMA DMAIC methodology comes handy in rectifying inventory related defects thereby creating an effective pharmacy inventory management system. Information technology makes methods of inventory management and methods of evaluating inventory management more efficient, more precise, and more accurate.

REFERENCES

1. Anantadjaya SP, Nawangwulan IM, Irhamsyah M, Carmelita PW. Supply chain management, inventory management and financial performance: evidence from manufacturing firms. Linguist Cult Rev. 2021;5(S1):781-94. doi: 10.21744/lingcure.v5nS1.1463.
2. Abu Zwaida T, Pham C, Beauregard Y. Optimization of inventory management to prevent drug shortages in the hospital supply chain. Appl Sci. 2021;11(6):2726. doi: 10.3390/app11062726.
3. Batson S, Herranz A, Rohrbach N, Canobbio M, Mitchell SA, Bonnabry P. Automation of in-hospital pharmacy dispensing: a systematic review. Eur J Hosp Pharm. 2021;28(2):58-64. doi: 10.1136/ejhpharm-2019-002081, PMID 32434785.
4. Walters LM, Barneva R. Drilling the data: students use Six Sigma DMAIC to improve dental practice inventory management. BRC Acad J Educ. 2017;6(1):57-74. doi: 10.15239/j.brcacadje.2017.06.01.ja03.
5. Muhia J, Waithera L, Songole R. Factors affecting the procurement of pharmaceutical drugs: a case study of Narok County referral hospital, Kenya. Med Clin Rev. 2017;3(4):20. doi: 10.21767/2471-299X.1000061.
6. Hartikainen PA, Koskinen T, Vainio K. Finnish pharmacists' perceptions of their work on the wards in hospitals and health centres. Eur J Hosp Pharm. 2014;21(4):251-4. doi: 10.1136/ejhpharm-2013-000406.
7. Kaakeh R, Sweet BV, Reilly C, Bush C, DeLoach S, Higgins B, *et al*. Impact of drug shortages on US health systems. Am J Health Syst Pharm. 2011;68(19):1811-9. doi: 10.2146/ajhp110210, PMID 21930639.
8. Xiao YY, Zhang RQ, Kaku I. A new approach of inventory classification based on loss profit. Expert Syst Appl. 2011;38(8):9382-91. doi: 10.1016/j.eswa.2011.01.127.
9. Franchetti M, Yanik M. Continuous improvement and value stream analysis through the lean DMAIC Six Sigma approach: a manufacturing case study from Ohio, USA. Int J Six Sigma Compet Advantage. 2011;6(4):278-300. doi: 10.1504/IJSSCA.2011.040676.
10. Jayswal A, Li X, Zanwar A, Lou HH, Huang Y. A sustainability root cause analysis methodology and its application. Comput Chem Eng. 2011;35(12):2786-98. doi: 10.1016/j.compchemeng.2011.05.004.
11. Allen TT, Tseng SH, Swanson K, McClay MA. Improving the hospital discharge process with Six Sigma methods. Qual Eng. 2009;22(1):13-20. doi: 10.1080/08982110903344812.
12. Tetteh E. Creating reliable pharmaceutical distribution networks and supply chains in African countries: implications for access to medicines. Res Social Adm Pharm. 2009;5(3):286-97. doi: 10.1016/j.sapharm.2008.08.001, PMID 19733829.
13. Kaku I, Xiao Y. A new algorithm of inventory classification based on the association rules. Int J Serv Sci. 2008;1(2):148-63. doi: 10.1504/IJSSCI.2008.019609.
14. Kumar S, Strandlund E, Thomas D. Improved service system design using Six Sigma DMAIC for a major US consumer electronics and appliance retailer. Int J Retail Distrib Manag. 2008;36(12):970-94. doi: 10.1108/09590550810919388.
15. Mo Yang HM, Seok Choi BS, Jin Park HJ, Soo Suh MS, Chae BK. Supply chain management Six Sigma: a management innovation methodology at the Samsung Group. Supply Chain Manag Int J. 2007;12(2):88-95. doi: 10.1108/13598540710737271.
16. Antony J. Six Sigma for service processes. Bus Process Manag J. 2006;12(2):234-48. doi: 10.1108/14637150610657558.
17. Buck CJ. Application of Six Sigma to reduce medical errors. In: Annual Quality Congress proceedings-American Society for Quality control. 2001;739-42.

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